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Reports
Shepherd,
R.G.

HYDROGEOLOGIC INVESTIGATION
FRASER EXPERIMENT STATION
U.S. FOREST SERVICE
GRAND COUNTY, COLORADO

Prepared for:

Mr. Gene Thomas, Engineer

Ms. Jesse Thompkin, Geologist

Mr. P. Wayne White, Contracting Officer

Project Number 8228

October, 1978

WILLARD OWENS ASSOCIATES INC

7391 West 38th Avenue
Wheatridge, Colorado 80033

Geotechnical Consultants
Engineering Geology, Geophysics
Ground Water Hydrology

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Soils & Foundation Engineering

October 27, 1978

Mr. P. Wayne White, Contracting Officer
Mr. Gene Thomas, Engineer
Ms. Jesse Thompkin, Geologist
U.S. Forest Service
Rocky Mountain Forest and
Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80526

RE: Hydrogeology Investigation
Fraser Experimental Station
Project Number 8228

Dear Wayne, Gene, and Jesse:

Enclosed are three (3) copies of our report entitled "Hydrogeology Investigation, Fraser Experiment Station, U.S. Forest Service, Grand County, Colorado". This report was done in conformance with the requirements for Part A, only, of our contract 53-82FT-8-25 (September 20, 1978, as amended). The final site map is not included herein; I will deliver this personally to you on Tuesday, October 31, 1978, when we review the report's findings in conference in Fort Collins.

If you have any questions regarding this report before the, please do not hesitate to contact our office.

Sincerely,

R. G. Shepherd

Russell G. Shepherd, Ph.D.
Certified Professional Geologist
Project Hydrogeologist

Willard G. Owens

Willard G. Owens, P.E.
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SUMMARY AND CONCLUSIONS

A hydrogeologic study was conducted for the U.S. Forest Service at the Fraser Experimental Forest Station in Section 3, T.2S., R.67W., southwest of Fraser in Grand County, Colorado, by personnel of Willard Owens Associates, Inc. The purpose of the study was to evaluate the adequacy of the existing well and water system for 20 years in the future, including fire protection considerations. In addition, recommendations regarding a potential pumping test, water quality analyses, and the location of potential well sites were requested. A plan and topographic map of the station was also requested, by change order, and this work was incorporated into the original contract (53-82FT-8-25).

We conducted a hydrogeologic reconnaissance of the area and returned to do test drilling and seismic profiles at the headquarters area. We surveyed and mapped the topography, buildings, power and water lines, roads, etc. at the site. We obtained necessary published and unpublished information regarding the hydrogeology and water system at the station.

We conclude that installation of a new well and water system will be necessary to insure a nonpolluted, potable water supply for a 20-year future. We identify two locations for well construction, a best (A on Figure 4) and alternative (B on Figure 4). We include a preliminary well design and recommend water quality parameters for measurement. We recommend that the existing surface-intake and pipeline system be slightly modified to provide fire protection in

the future. That is, a subsurface storage tank will provide large enough quantities of water for fire protection equipment, be it a high capacity pump or a fire truck.

If these recommendations are accepted, we are ready to provide additional services, as part of our contract or on change order status, as the water system is adapted and basic information upon which future decisions are necessary is developed.

The United States Forest Service maintains and operates an Experimental Forest Headquarters in Section 3, T.2S., R.76W., Grand County, Colorado for the Fraser Experimental Forest (Figure 1). The experiment station is near the confluence of St. Louis and West St. Louis Creeks, approximately 6 miles southwest of Fraser, Colorado. It consists of cabins, a shop, a mess hall, a lodge, an office, trailers, and other buildings and equipment necessary for the operation of the experiment station. The total area of the headquarters and vicinity is approximately 20 acres.

On September 20, 1978, the Forest Service engaged Willard Owens Associates, Inc., to conduct a hydrogeologic study at the station. The object of the study was to evaluate the possibility of continued use of the existing well and distribution system to provide an adequate potable water system for a 20-year future. An additional task was to evaluate the water supplies for fire protection needs at the station.

The Forest Service agreed to provide knowledge of existing features and plans of future expansions, including an aerial photograph of the station area (scale 1" = 100') and a site topographic and improvements map. Willard Owens Associates, Inc., received a photo on October 6, 1978. In addition, project coordinator, Gene Thomas, U.S. Forest Service, Loveland, notified us that the site map being prepared by the Forest Service would not be forthcoming, and he inquired as to whether we could provide this detailed map. We responded that we could provide this and the appropriate change order of work

was incorporated into our contract on October 16, 1978. At that time we finally received all background material and information necessary to begin the project, as modified by the change order.

SUMMARY OF WORK

Work performed included a site investigation by the project hydrogeologist, auger drilling of test holes to determine the character and depth of the alluvium at selected locations at the station, two seismic traverses, made for the same reason, and a detailed site survey of all existing pertinent features at the station. First, a geologic reconnaissance was conducted to obtain an overview of the water system and the general hydrogeology at the station. The best locations for test drilling and seismic lines were identified, and this work was done. Information necessary to make recommendations regarding the future reliability of the present well and distribution system was obtained. Finally, best and alternative sites for the construction of a new well were identified. A preliminary well design was prepared and methods for its testing were evaluated, although final testing specifications await drilling results.

GENERAL GEOLOGIC SETTING

The Experiment Station is located in southeastern Middle Park, a synclinal basin containing structually deformed sedimentary strata of Mesozoic and Tertiary age (Figure 2). The Front Range to the east of Middle Park, the Park Range to the west, and portions of the floor of the basin consist of outcrops of Precambrian igneous and metamorphic rocks, principally granite, gneiss, and schist. Pleistocene glacial deposits, including till and outwash gravels, with modern river alluvium, extend along major river valleys entering Middle Park. One such valley is St. Louis Creek at the Experiment Station (Figure 3). Details of the geology of Middle Park can be found in RMAG (1957), Voegeli (1965), and Taylor (1975).

SITE HYDROGEOLOGY

Test drilling and seismic profiles (Figure 4) revealed that the surface formation at the station, which is a Quaternary alluvium consisting of poorly sorted, muddy, sandy gravel (Figure 3), is apparently as much as 60 feet thick in places. The alluvium is reworked glacial moraine sediment, examples of which can be seen further upstream along St. Louis and West St. Louis Creeks. Adjacent outcrops suggest that, beneath the alluvium and glacial deposits, the bedrock at the station is biotite gneiss. However, it is probable that a fault exists beneath the alluvium along St. Louis Creek (Figure 3); thus, the bedrock may alternatively be sandstone or claystone. Nevertheless, the type of bedrock at the station is not of great significance in this study because the test drilling and seismic profiles (Figures 5 and 6) indicated that the alluvium is sufficiently thick and coarse to be a satisfactory aquifer for the station's water supply. Figure 4 shows the location of the test holes and seismic lines.

Because of excessively hard drilling conditions, the driller was able to complete the two test holes to depth of only 20 feet for test hole one and only nine feet for test hole two. Sandy gravel, with numerous clasts of boulder size, was encountered from surface to total depth in both holes. Nevertheless, the tests were of some value in establishing minimum depths and thicknesses, in providing knowledge useful in the seismic work, and in showing the character of the material to depths greater than expected pipeline depths.

The seismic work indicates that experiment station is in an alluvial gravel terrace between West St. Louis Creek, which flows on the terrace, and St. Louis Creek, which has cut into the gravel and formed the terrace (Figure 3). A subsurface strath terrace (bedrock) is also indicated beneath the station. Elevations of the streams with respect to gravel (Figure 3) and seismic results (Figures 5 and 6) suggest that the water table generally slopes from northwest to southeast beneath the surface at the station.

Because the drainage area of St. Louis Creek is several times that of West St. Louis Creek, discharges are higher and the alluvium is coarser in the St. Louis Creek valley. The data compiled suggest that the thickness of alluvial fill is also greater in St. Louis Creek.

The water supply for the station consists of a well near the confluence of Spruce Creek at West St. Louis Creek, approximately 1200 feet west-northwest of the buildings at the station. Although the well was not recorded with the State Engineer's Office because it was drilled in 1956, before records were required, a log of the material encountered during drilling and other information on the well is given in Voegeli (1965). The well is reported to be 60 feet deep with 2 feet of topsoil overlying 58 feet of glacial deposits, mainly clay, gravelly clay, tight, rusty sandstone, and jointed, sandy clay. The well, being in the drainage of West St. Louis Creek, encounters smaller amounts of coarse material than would a well drilled in the main drainage of St. Louis Creek to the east.

The well has metal 8" casing and when it was measured by Voegeli on August 11, 1960, the static water level was 6 feet below the top of the casing. It was 6.25 feet on October 10. 1978. The pump on the well is a Sears Homemart 30 (Model 390 4102E65) deep well jet pump, 1 horsepower. The system has a tank with a water storage capability of an estimated 200 gallons in the pumphouse. The depth of setting and the intake of the pump is not known. A chemical analysis of the water performed by the U. S. Geological Survey yielded 10 parts per million sulfate, 1.5 parts per million chloride, 0.3 parts per million fluoride, 0.2 parts per million nitrate, 113 parts per million dissolved solids, 83 parts per million hardness (calcium magnesium), 182 micromhos

specific conductance, and a pH of 7.2. This water is apparently of acceptable quality, but not all mandatory or recommended parameters were measured. The distribution system reportedly consists of galvanized pipes which were installed in 1938. The diameter of the piping system is reportedly 2 inches in main lines and smaller in side lines. A recurring problem with the lines is that they were not buried deeply enough when installed and consequently some freeze during some winters when there is sufficient snow pack, especially at road crossings. Another problem is that they are reportedly deteriorating and beginning to leak.

Tied into the existing water system is a pipeline which also extends west-northwest up West St. Louis Creek approximately 3000 feet from the station buildings and brings water from a surface intake installed in the channel of West St. Louis Creek near where Horse Creek flows into it. The well supplies water to the cabins, the garage, the office, the lodge, the lounge, dormitory, and two trailers parked permanently at the station.

Table 1 lists the water taps for the station, categorized according to building. Personnel at the Forest Service Experiment Station provided us with an estimate that 34 people would be the total most likely maximum number of people that might be utilizing the station at one time in the 20 year future of the projected requirements. We have based our projections regarding water use on an estimate of 40 people possibly occupying the station at once at some

time in the next 20 years. On this basis, a flow of fifteen gallons per minute served as our well design peak requirement.

The existing well reportedly supplies sufficient water of satisfactory quality to meet existing requirements. However, the age of the distribution system and its reported state of deterioration mandates that a new distribution system be installed. Because the existing well is more than a thousand feet from the nearest point of use of the water, it will be less expensive to construct a new well near the buildings than to put in a new pipeline from the old well. In addition, it is likely that, to meet requirements for 40 people, the existing well will require rehabilitation during the next 20 years. This procedure will be unnecessary with a new well properly designed for the increased rate.

RECOMMENDATIONS

Based on the foregoing evaluation, we recommend that a new well and distribution system be constructed at the experiment station. Our seismic and test drilling programs indicated that the best potential well location is south of the office (Location A, Figure 4). There the alluvium is indicated to be thicker and coarser than at the alternative site, B, or other potential sites to the north or west. We expect that drilling at location A will encounter the water table within approximately 30 feet of the surface. The seismic results also indicate that bedrock is probably in excess of 60 feet deep at Site A.

Well Design

A preliminary design for construction of a well near Location A is shown in Figure 7. This is only one of several designs that would be satisfactory, depending upon the method of drilling, the final thickness and character of alluvium encountered, and the particular capabilities of the driller chosen for the work. We will be happy to consult with you on changes in the design based on these currently unspecified factors when they become known.

Pumping Test

We recommend that the pumping test be done in two stages. First a step test should be done to establish the discharge to be used for a longer continuous test. Specification of the lengths and discharges of the steps will depend on the depth to water and character of the material encountered

during drilling, and cannot be finalized now. However, the first test discharge should be very low, and drawdown should be carefully recorded. Results from the first step test will control the subsequent step test times and discharges. Again, we will be happy to consult with your project geologist or engineer on these details when the need arises.

Quality Testing

Table 2 lists the water quality parameters we recommend for measurement for the new well. This list is quite complete regarding known sources of harmful constituents, and the results will satisfy all substantive legal and moral requirements for testing public supplies. Special procedures will be required when the samples are collected; thus we understand that you would like one of our representatives to do the sampling. We, of course, will be happy to do this.

Fire Protection System

We evaluated the alternatives of including fire fighting capabilities in the new water system, developing a new, independent fire protection system, or using the old system to provide water for fire protection.

We concluded that because overall discharge requirements of the new system will not approach those of a fire protection system, it will not be financially prudent to design the new well and distribution system to also have fire fighting capabilities. Although a new well could be designed and drilled for fire only, or a larger pump could be installed in the existing well, the problems of distribution of fire-

extinguishing discharges (50+ gallons per minute), and additional high costs involved in these alternatives prevents either of them from being viable. Instead, we recommend that the existing surface intake and pipeline system that diverts water from West St. Louis Creek be used for fire protection. It is our opinion that a subsurafce storage tank of 1000 to 2000 gallons can, in a convenient location, be inexpensively tied into the pipeline from the surface intake. Access to the storage tank can be provided for a fire truck intake; the system can be prevented from freezing in the winter by allowing a few gallons per minute of water to continuously flow through the tank. This small discharge either can be channeled back to either of the adjacent creeks, or induced to infiltrate into the terrace gravel through a perforated infiltration pipe. If desired, a submersible, high discharge pump can be installed in the storage tank.

We have enjoyed working with you on this project and look forward to Part B of the contract.

Respectfully Submitted,

R. G. Shepherd

Russell G. Shepherd, Ph.D.
Certified Professional Geologist
Project Hydrogeologist

Willard G. Owens

Willard G. Owens, P.E.
Certified Professional Geologist

RGS:bja

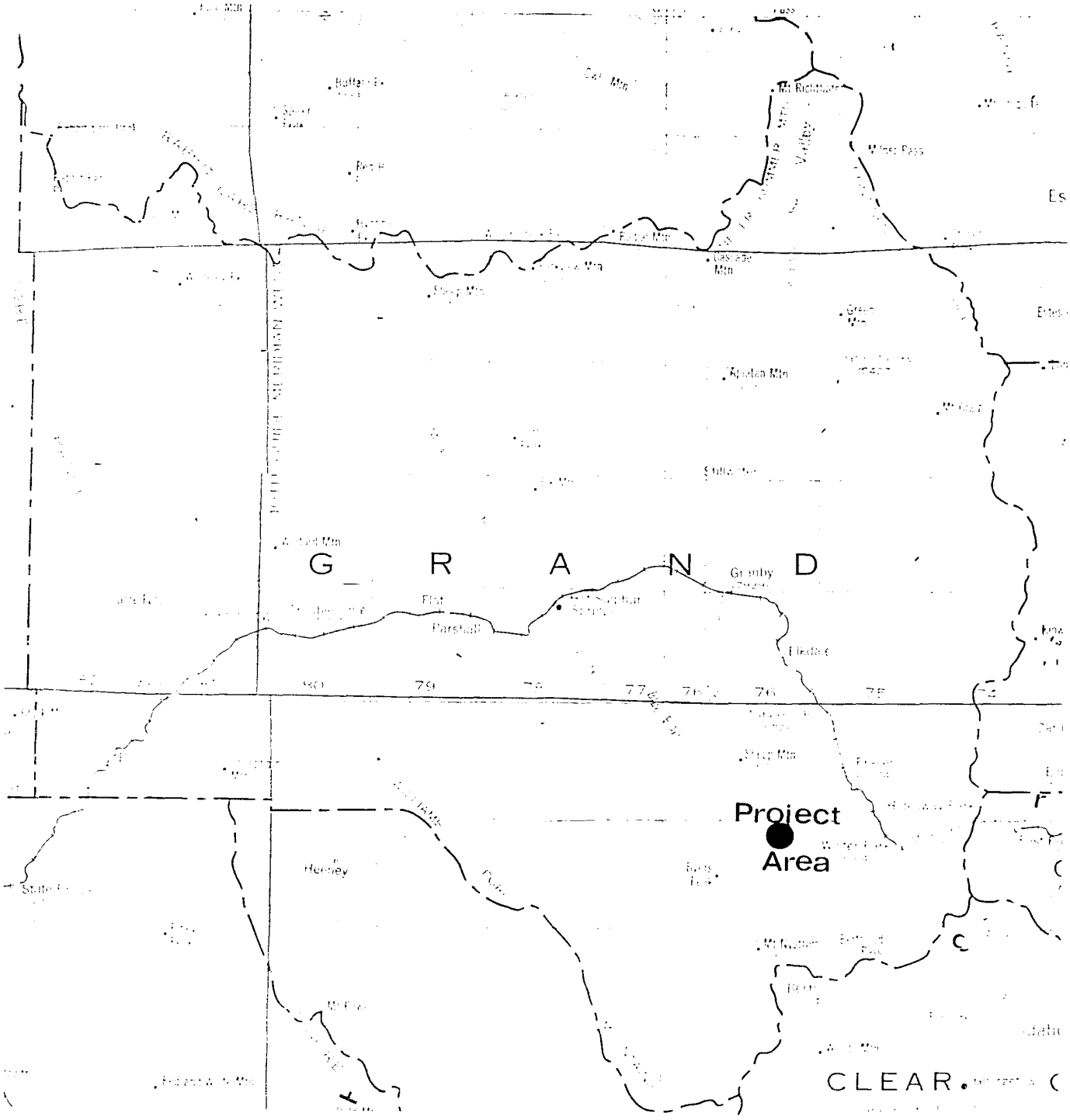


FIGURE 1 - Map showing location of Fraser Experiment Station Project Area in Grand County, Colorado

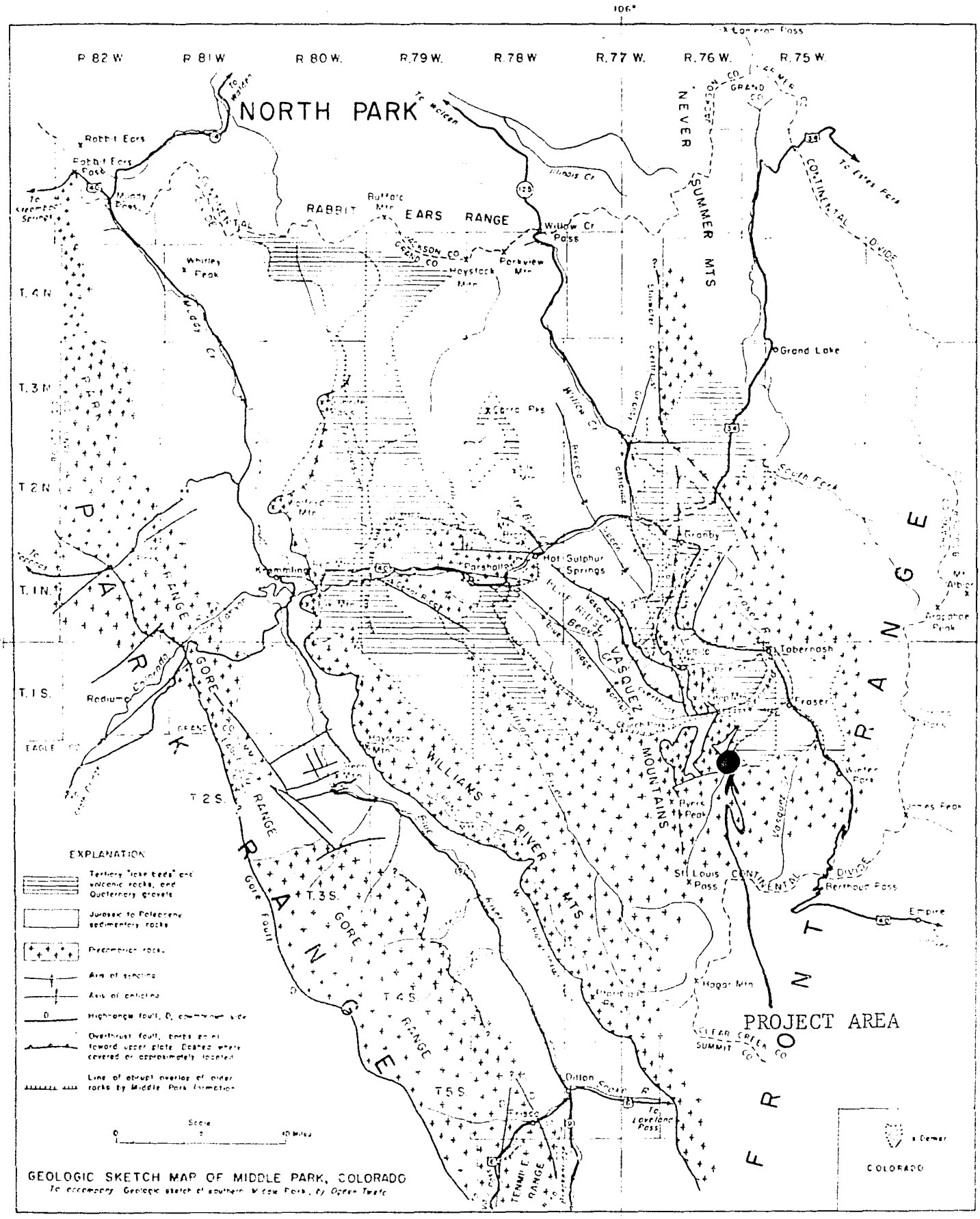
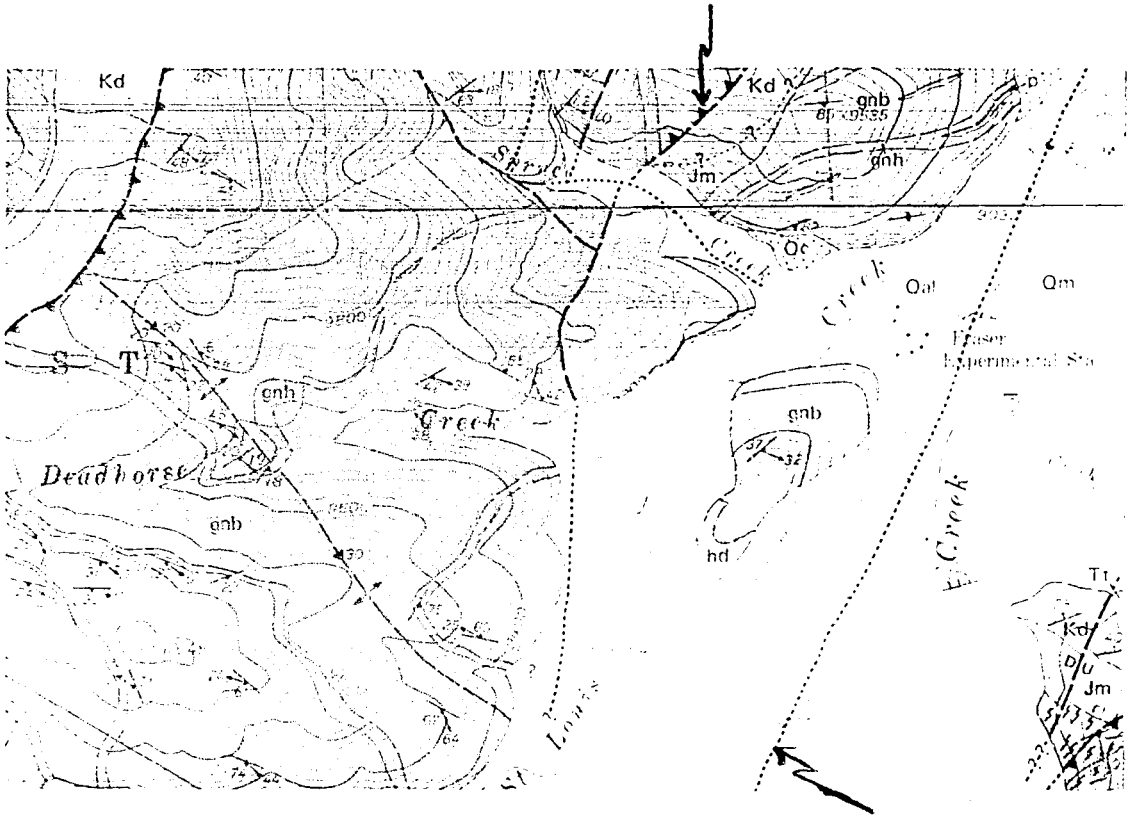


FIGURE 2 - Map showing general geology of Middle Park; location of Fraser Experiment Station Project Area

Thrust Fault



From Taylor (1975)

Normal Fault
(Inferred)

Scale 1" = 2000 feet

Qal - Quaternary alluvium, including glacial outwash and modern river deposits

Qc - Colluvium

Qm - Glacial moraine deposits, poorly sorted mud, sand, and gravel

Kd - Dakota Sandstone (Cretaceous)

Jm - Morrison Formation (Jurassic) claystone and mudstone

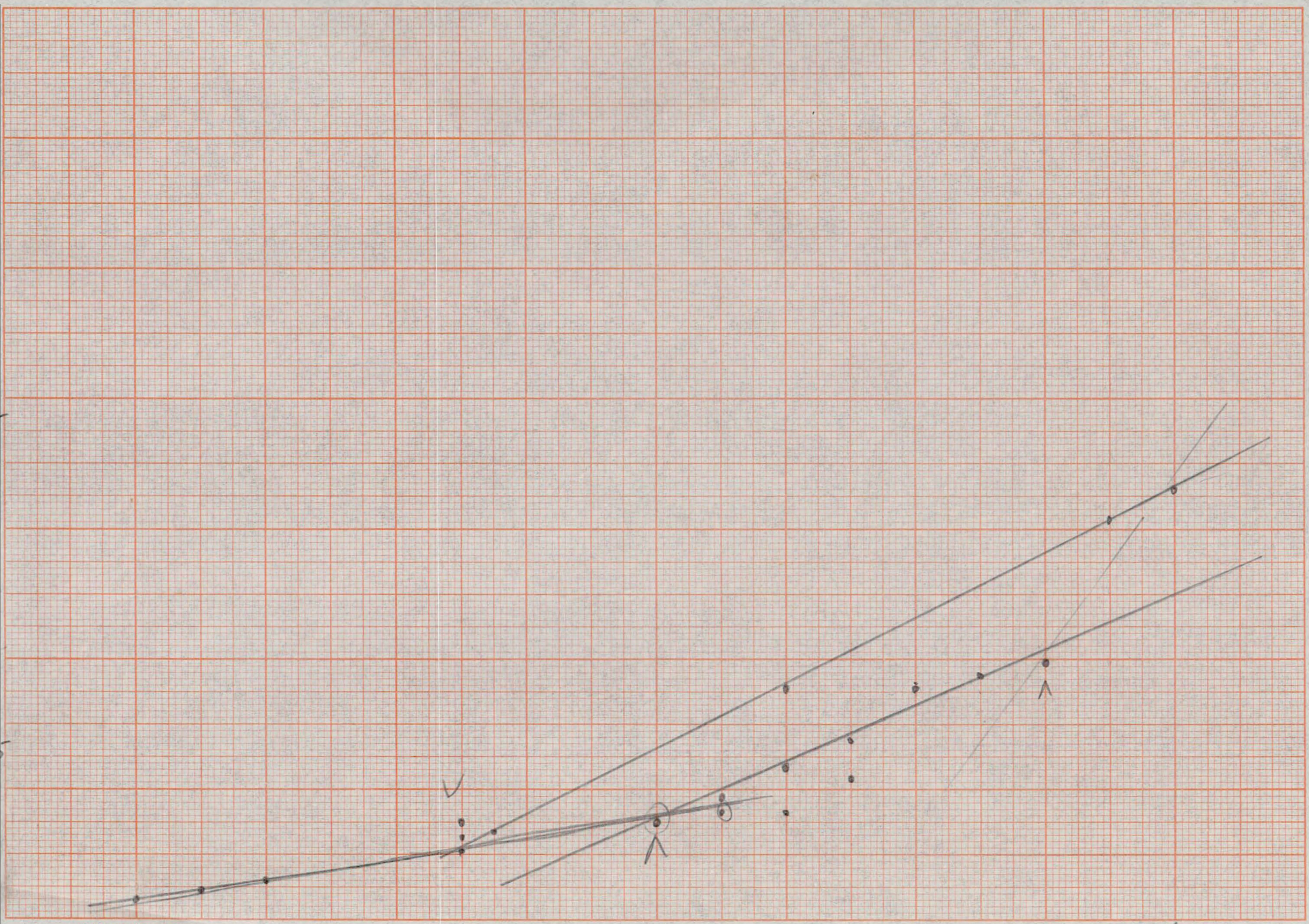
hd - Hornblende Diorite (Precambrian)

gnb - Biotite Gneiss (Precambrian)

gnh - Hornblende Gneiss (Precambrian)

FIGURE 3 - Geologic Map of Experiment Station Area

FIGURE 4. Aerial photo showing locations of auger test holes (T1 and T2) and seismic profiles (S1 and S2) done at Fraser Experiment Station. Scale is 1" = 141.7 feet.



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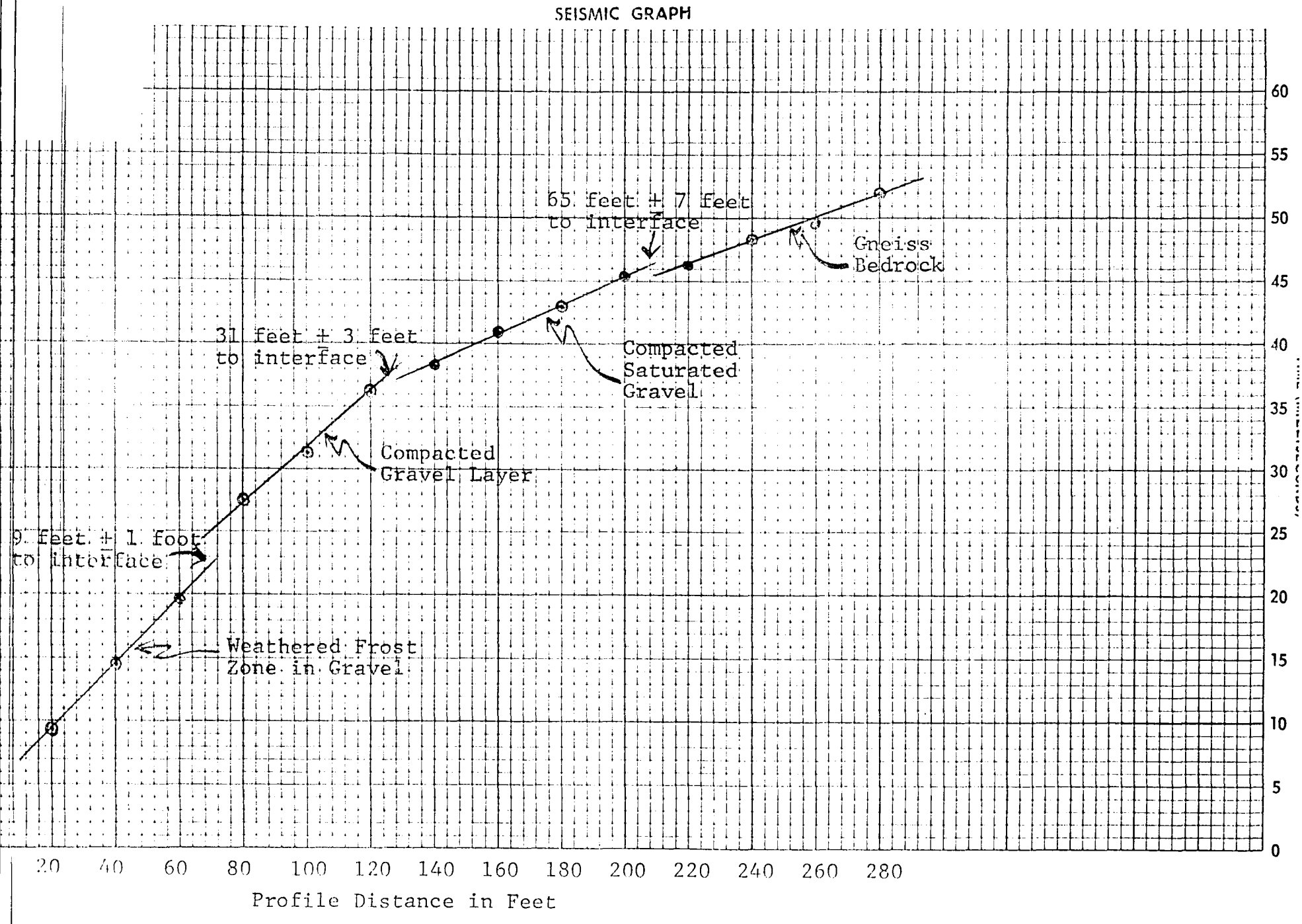

FIGURE 5. DATA AND INTERPRETATION FROM SEISMIC PROFILE 2, NEAR OFFICE

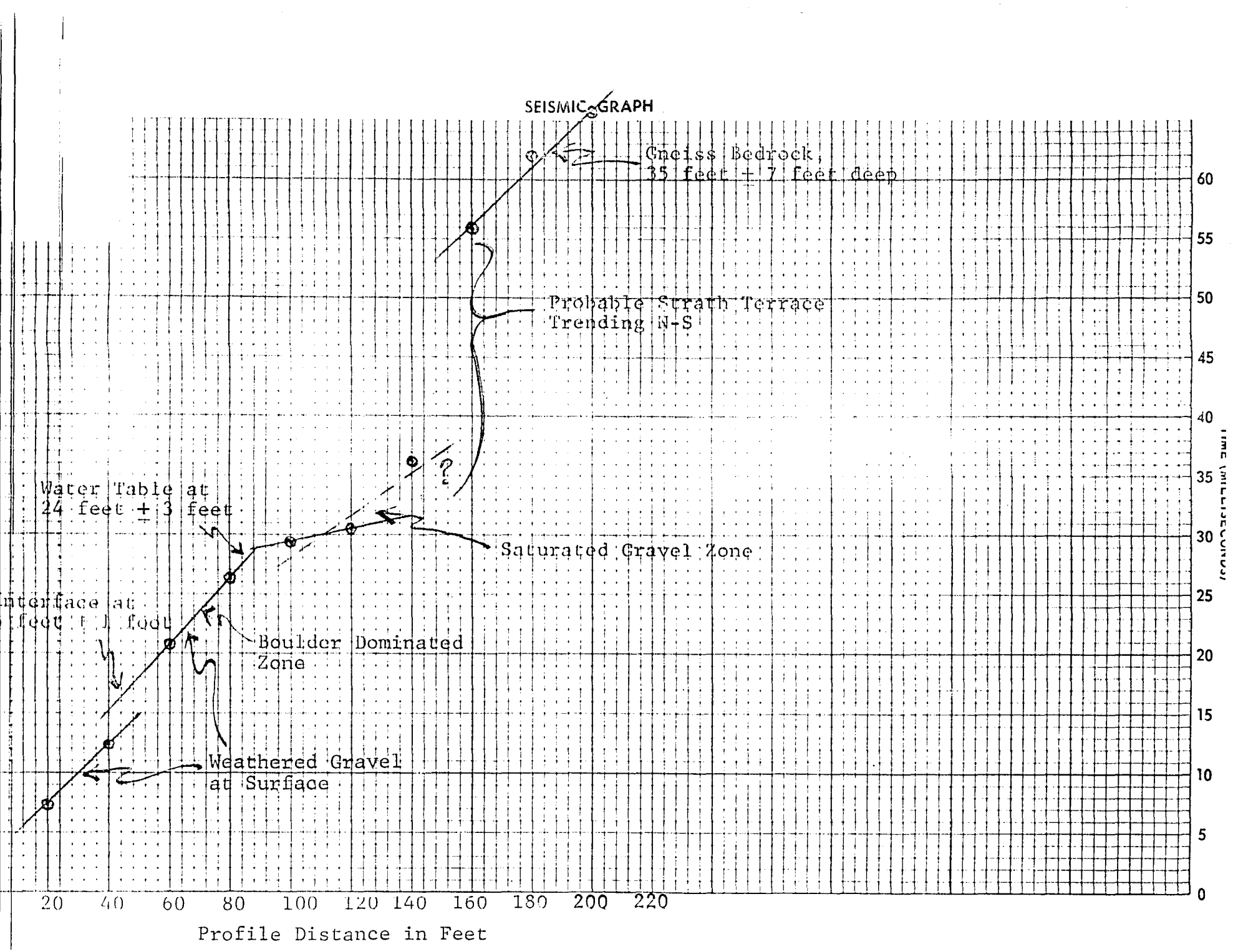

FIGURE 6. RESULTS AND INTERPRETATION OF SEISMIC TRAVERSE #1

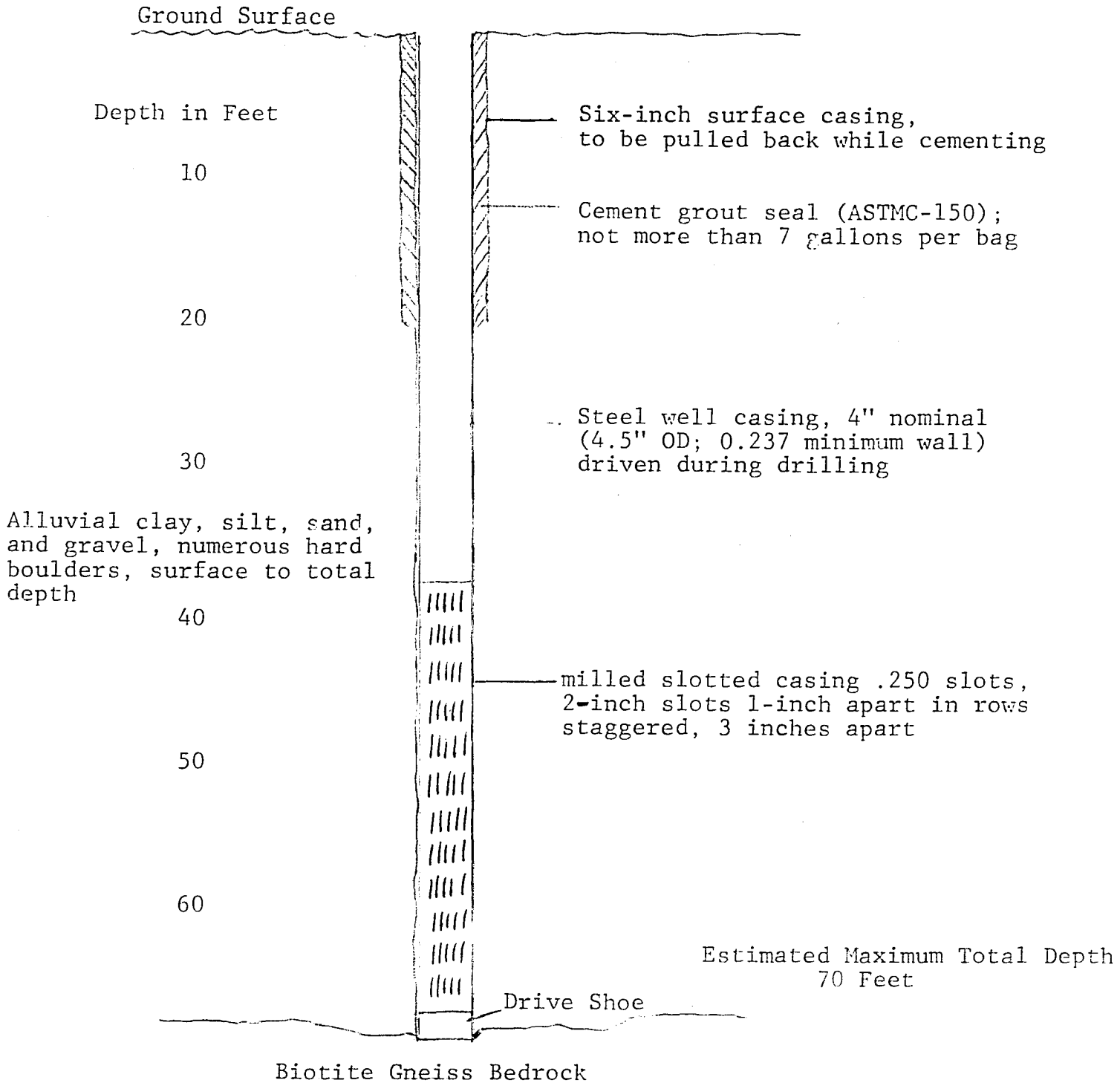
Ground Surface
Depth in Feet
10
20
30
40
50
60
Six-inch surface casing, to be pulled back while cementing
Cement grout seal (ASTMC-150); not more than 7 gallons per bag
Steel well casing, 4" nominal (4.5" OD; 0.237 minimum wall) driven during drilling
Alluvial clay, silt, sand, and gravel, numerous hard boulders, surface to total depth
milled slotted casing .250 slots, 2-inch slots 1-inch apart in rows staggered, 3 inches apart
Estimated Maximum Total Depth 70 Feet
Drive Shoe
Biotite Gneiss Bedrock

FIGURE 7. Preliminary design for Fraser Experiment Station well, using air-rotary drive and drill method.

TABLE 1

WATER OUTLETS AT FRASER EXPERIMENT STATION

Building	Water Outlets
Lodge	2 Outside Faucets 1 Laundry Sink 2 Toilets 1 Kitchen Sink 1 Bath Lavoratory 1 Bath Tub 1 Shower
Office	1 Toilet 1 Laboratory Sink 1 Lavoratory
Shop	1 Outside Faucet
Cabin #1	1 Outside Faucet 1 Kitchen Sink 1 Bath Lavoratory 1 Shower 1 Toilet
Cabin #2	1 Outside Faucet 1 Kitchen Sink 1 Bath Lavoratory 1 Shower 1 Toilet
Lounge and Bath House	4 Toilets 2 Urinals 6 Lavoratories 1 Mop Sink 3 Outside Faucets 4 Showers
Dorm	1 Lavoratory 1 Toilet
1 Kitchen Trailer 2-2 Bunk 1-4 Bunk	

TABLE 2

LIST OF WATER QUALITY PARAMETERS RECOMMENDED FOR MEASUREMENT

MANDATORY		ALSO RECOMMENDED	
Parameter	Limits	Parameter	Limits
Turbidity	1 TU	Color	15 Cobalt Units
Arsenic	0.05 mg/l	Total Hardness as $CaCO_3$	mg/l
Barium	1. mg/l	Calcium as $CaCO_3$	
Cadmium	0.010 mg/l	Magnesium	125 mg/l
Chromium	0.05 mg/l	Sodium	250 mg/l
Fluoride	2.4 mg/l	Chloride	250 mg/l
Lead	0.05 mg/l	Sulfate	250 mg/l
Mercury	0.002 mg/l	Phenolphtalein Alkalinity	mg/l
Nitrate as N	10 mg/l	Total Alkalinity	mg/l
Selenium	0.01 mg/l	Dissolved Solids	500 mg/l
Silver	0.05 mg/l	Specific Conductance	Micromhos
Chlorinated Hydrocarbons Pesticides		Ammonia as N	mg/l
Endrin	0.0002 mg/l	Boron	mg/l
Lindane	0.004 mg/l	Copper	1.0 mg/l
Methoxychlor	0.1 mg/l	Iron	0.3 mg/l
Toxaphene	0.005 mg/l	Manganese	0.05 mg/l
Herbicides		Molybdenum	mg/l
2,4 - D	0.1 mg/l	Phosphate as P	mg/l
2,4,5 - TP	0.01 mg/l	Zinc	5.0 mg/l
Radioactivity			
Gross Alpha	15 pCi/l		
Gross Beta	50 pCi/l		
Radium 226	5 pCi/l		
Coliform Bacteria	1 per 100 ml		